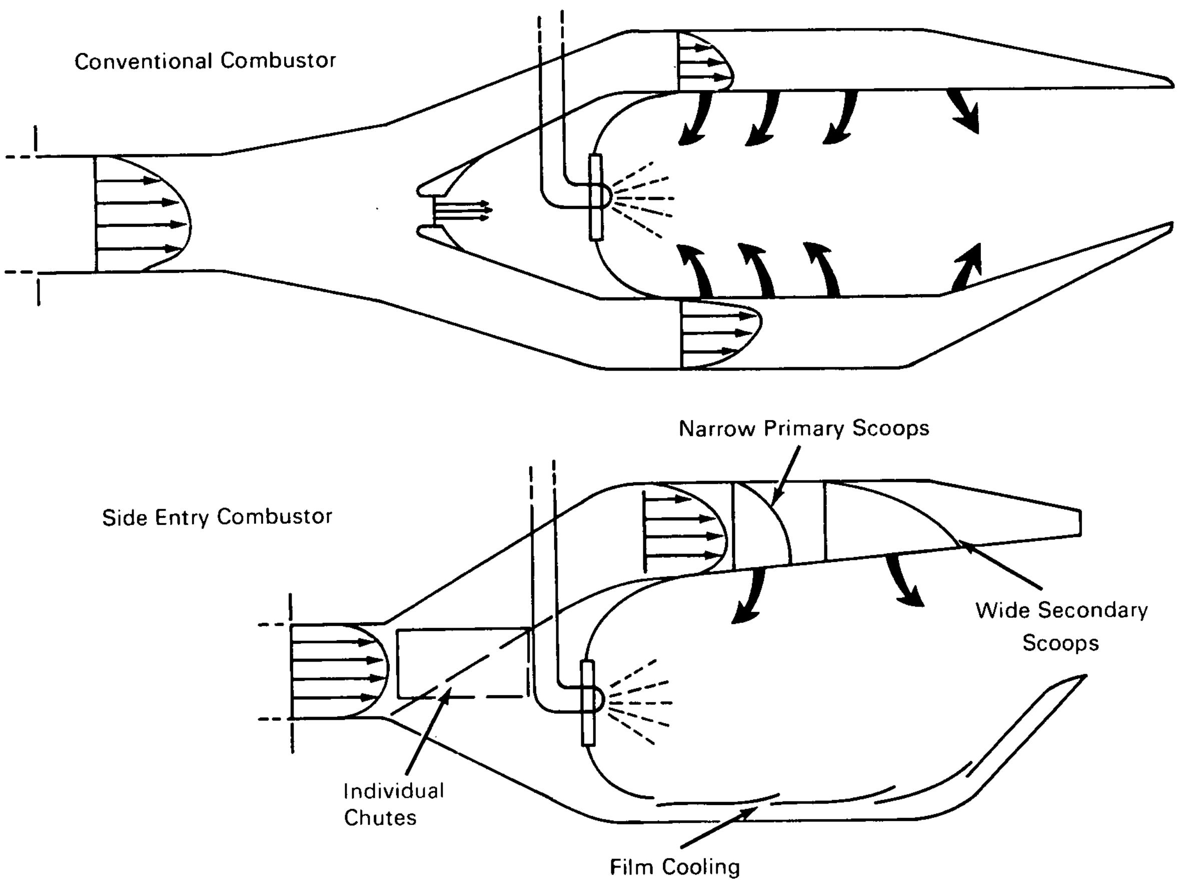
NASA TECH BRIEF

Gas Turbine Combustor Insensitive to Compressor Outlet Distortion



The problem:

To develop a short-length annular combustor for turbojet engines, in which the combustor exit temperature profile is insensitive to shifts in combustor inlet radial velocity profile. Conventional annular combustors, as shown in the figure, are characterized by relatively long length to accommodate several air entries. These entries are supplied from annular flow passages on both sides of the combustion space. Good performance is obtained with a fixed inlet radial velocity profile. However, a shift in the inlet radial velocity profile will change the air distribution between inner and outer annuli, causing the exit temperature profile from the combustor to change. A shift in combustor

(continued overleaf)

inlet velocity profile occurs in some engines as engine rpm is varied. Such shifts can also be induced by engine inlet flow distortions.

The solution:

A combustor design in which air for the combustion process enters from only one side of the annular combustor. The air enters through scoops of full annular height, each of which captures the same fraction of the incoming air regardless of shifts in radial velocity profile.

How it's done:

Using only the annulus for combustor air entry, as shown in the figure, air distribution is controlled by using individual scoops in the annulus to capture and inject the required air fractions. These scoops are made full annular height so that, regardless of radial velocity profile variations, each scoop captures the required air mass fraction. All of the air along the annular height (for a small circumferential segment) is directed through a single opening into the combustor. Therefore, shifts in the radial velocity profile of the air entering the combustor will not affect the combustion process or alter the exit temperature profile.

Overall length is reduced by combining part of the combustor with a short diffuser section and using only two rows of scoops for the combustor. A single row of primary scoops provides the air required for stoichiometric combustion. A row of wide secondary scoops in line with the primary scoops provides the air required to penetrate across the full height of the mixing zone to cool the inner diameter (turbine blade hub region). A portion of air is directed between secondary scoops through flush slots to cool the outer diameter (turbine blade tip region). Except for a small amount of air swirling with the fuel spray and for film cooling of the inner diameter walls, all of the combustor air is supplied from one side of the combustor.

Notes:

1. Experiments with a simulated combustor section of side entry design yielded results to verify these principles. The exit temperature profiles obtained match the ideal profiles very well and there were no undesirable local hot spots. The exit temperature profile did not change appreciably when major changes were made in the inlet radial velocity profile. Other standards of performance such as combustion efficiency and overall combustor pressure loss were equal to or superior to conventional combustors.
2. The following documentation may be obtained from:

   Clearinghouse for Federal Scientific
   and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   NASA-TN-D-5570 (N70-18126), Performance of a Turbojet Combustor Insensitive to Inlet Airflow Distortion
3. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B70-10312

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA, Code GP, Washington, D.C. 20546.

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